**WHAT IS CLAIMED IS:**

1. A method for clustering data comprising the steps of

a. constructing a graph of a database in which each node of the graph represents a component part of the database, and every two nodes represent neighboring component parts associated by an arc representing a coupling value,

b. selecting chosen component parts as blocks with unselected neighboring component parts coupled with a selected block according to coupling values,

c. coarsening the graph by performing iterated weighted aggregation wherein at each iteration of the coarsening blocks are selected and coupling values updated between unselected blocks to form larger blocks to obtain hierarchical decomposition of the database and to form a pyramid structure,

d. adjusting the coupling between blocks.

e. detecting saliency of segments in the pyramidal structure,

f. determining which component parts belong to a segment by computing recursively a degree of attachment of every component part to each of the blocks in the pyramid, and

g. scanning the pyramid from coarse to fine starting at the level a segment is detected and applying relaxation sweeps to sharpen the boundaries of a segment.

2. A method for processing an image comprising the steps of

a. constructing a graph of an image in which each node of the graph represents a pixel of the image, and every two nodes represent neighboring pixels associated by an arc representing a coupling value,

b. selecting chosen pixels as blocks with unselected neighboring pixels coupled with a selected block according to coupling values,

c. coarsening the graph by performing iterated weighted aggregation wherein at each iteration of the coarsening blocks are selected and coupling values updated between unselected blocks to form larger blocks
to obtain hierarchical decomposition of the database and to form a pyramid structure,.

d. adjusting the coupling between blocks.

e. detecting saliency of segments in the pyramidal structure,

f. determining which pixels belong to a segment by computing recursively a

degree of attachment of every pixel to each of the blocks in the pyramid, and

g· scanning the pyramid from coarse to fine starting at the level a segment is detected and applying relaxation sweeps to sharpen the boundaries of a segment.

3. A method for processing an image comprising the steps of

a. constructing a graph of an image in which each node of the graph represents a pixel of the image, every edge connects a pair of neighboring pixels and a weight is associated with each edge reflecting contrast in the corresponding location in the image,

b. selecting some pixels as blocks and associating unselected neighboring pixels with a selected block to form aggregates,

c. detecting segments by a recursive coarsening using weighted aggregation which induces a pyramid structure over the image, the segments detected appearing as an aggregate at some level in the pyramid,

d. said recursive coarsening comprising iterated weighted aggregation wherein at each iteration of the coarsening blocks are selected and weights are updated between unselected blocks to form larger blocks to obtain hierarchical decomposition of the image into aggregates,

e. determining salient segments from among the segments detected in the pyramidal structure, and

f. sharpening the segments to determine its boundaries more accurately.

4. The method according to claim 3 including the further step of determining which pixels belong to a segment by computing recursively a degree of attachment of every pixel to each of the blocks in the pyramid.

5. The method according to claim 3 including the further step of scanning the pyramid from coarse to fine starting at the level a segment is detected and applying relaxation sweeps to sharpen the boundaries of a segment.

6. The method according to claim 3 including the further step of computing at least one property of the aggregate it represents during recursive coarsening for every block in a new level of the pyramid.

7. The method according to claim 6 including the further step of updating weights to account for properties computed during recursive coarsening for every edge in the graph.

8. The method according to claim 3 including the further step of updating weights during cursive coarsening to increase weights between neighboring aggregates exhibiting sharp sections that connect by a smooth curve.

9. The method according to claim 3 including the further step of applying a top-down sharpening during the recursive coarsening at any given level by first going down a preselected number of levels to check the boundaries of detected segments, updating weights, and rebuilding the pyramid to the originating level to sharpen distinction between aggregates before building the pyramid to the next upper level.

10. The method according to claim 3 including the further step of going back down a preselected number of levels to check sub-aggregates regarding boundaries, update and rebuild the pyramid before proceeding to the next upper level as part of each iteration of weight aggregation.

11. The method according to claim 3 including the further step of detecting sharp transitions in pixels in the image.

12. The method according to claim 3 including the further step of establishing a threshold to determine edge pixels in the image.

13.The method according to claim 12 including the further step of applying edge tracing by best fitting line segments of aggregates to determined edge pixels.

14. The method according to claim 13 including the further step of producing a polygonal approximation of an aggregate's boundary.

15.The method according to claim 3 including the further step of comparing the properties of neighboring aggregates.

16.The method according to claim 3 including the further step of modifying weights to

control intensity contrast between aggregates during recursive coarsening.

17. The method according to claim 3 including the further step of determining variance of an aggregate relative to a neighboring aggregate.

18. The method according to claim 3 including the further step of determining multiscale variance of an aggregate to detect its texture.

19. The method according to claim 3 including the further step of determining average variance at finer scales to determine a relationship between aggregates.

20. Apparatus for clustering data comprising a computer processor programmed

a. for constructing a graph of a database in which each node of the graph represents a component part of the database, and every two nodes represent neighboring component parts associated by an arc representing a coupling value,

b. to select chosen component parts as blocks with unselected neighboring component parts coupled with a selected block according to coupling values,

c. to coarsen the graph by performing iterated weighted aggregation wherein at each iteration of the coarsening blocks are selected and coupling values updated between unselected blocks to form larger blocks to obtain hierarchical decomposition of the database and to form a pyramid structure,

d. to adjust the coupling between blocks.

e. to detect saliency of segments in the pyramidal structure,

f. to determine which component parts belong to a segment by computing recursively a degree of attachment of every component part to each of the blocks in the pyramid, and

g. for scanning the pyramid from coarse to fine starting at the level a segment is detected and applying relaxation sweeps to sharpen the boundaries of a segment.

21. Apparatus for processing an image comprising a computer processor programmed

a. for constructing a graph of an image in which each node of the graph represents a pixel of the image, and every two nodes represent neighboring pixels associated by an arc representing a coupling value,

b. for selecting chosen pixels as blocks with unselected neighboring pixels

coupled with a selected block according to coupling values,

c. for coarsening the graph by performing iterated weighted aggregation wherein at each iteration of the coarsening blocks are selected and coupling values updated between unselected blocks to form larger blocks to obtain hierarchical decomposition of the database and to form a pyramid structure,

d. for adjusting the coupling between blocks.

e. for detecting saliency of segments in the pyramidal structure,

f. for determining which pixels belong to a segment by computing recursively a degree of attachment of every pixel to each of the blocks in the pyramid, and

g. for scanning the pyramid from coarse to fine starting at the level a segment is detected and applying relaxation sweeps to sharpen the boundaries of a segment.

22. Apparatus for processing an image comprising a computer processor programmed

a. for constructing a graph of an image in which each node of the graph represents a pixel of the image, every edge connects a pair of neighboring pixels and a weight is associated with each edge reflecting contrast in the corresponding location in the image,

b. for selecting some pixels as blocks and associating unselected neighboring pixels with a selected block to form aggregates,

c. for detecting segments by a recursive coarsening using weighted aggregation which induces a pyramid structure over the image, the segments detected appearing as an aggregate at some level in the pyramid,

d. said recursive coarsening comprising iterated weighted aggregation wherein at each iteration of the coarsening blocks are selected and weights are updated between unselected blocks to form larger blocks to obtain hierarchical decomposition of the image into aggregates,

e. for determining salient segments from among the segments detected in the pyramidal structure, and

f. for sharpening the segments to determine its boundaries more accurately.

23. Apparatus according to claim 22 wherein the computer processor is further programmed for determining which pixels belong to a segment by computing

recursively a degree of attachment of every pixel to each of the blocks in the pyramid.

24. Apparatus according to claim 22 wherein the computer processor is further programmed for scanning the pyramid from coarse to fine starting at the level a segment is detected and applying relaxation sweeps to sharpen the boundaries of a segment.

25. Apparatus according to claim 22 wherein the computer processor is further programmed for computing at least one property of the aggregate it represents during recursive coarsening for every block in a new level of the pyramid.

26.Apparatus according to claim 25 wherein the computer processor is further programmed for updating weights to account for properties computed during recursive coarsening for every edge in the graph.

27.Apparatus according to claim 22 wherein the computer processor is further programmed for updating weights during recursive coarsening to increase weights between neighboring aggregates exhibiting sharp sections that connect by a smooth curve.

28. Apparatus according to claim 22 wherein the computer processor is further programmed for applying a top-down sharpening during the recursive coarsening at any given level by first going down a preselected number of levels to check the boundaries of detected segments, updating weights, and rebuilding the pyramid to the originating level to sharpen distinction between aggregates before building the pyramid to the next upper level.

29. Apparatus according to claim 22 wherein the computer processor is further programmed for going back down a preselected number of levels to check sub-aggregates regarding boundaries, update and rebuild the pyramid before proceeding to the next upper level as part of each iteration of weight aggregation.

30. Apparatus according to claim 22 wherein the computer processor is further

programmed for detecting sharp transitions in pixels in the image.

31. Apparatus according to claim 22 wherein the computer processor is further programmed for establishing a threshold to determine edge pixels in the image.

32. Apparatus according to claim 31 wherein the computer processor is further programmed for applying edge tracing by best fitting line segments of aggregates to determined edge pixels.

33. Apparatus according to claim 32 wherein the computer processor is further programmed for producing a polygonal approximation of an aggregate's boundary.

34.Apparatus according to claim 22 wherein the computer processor is further programmed for comparing the properties of neighboring aggregates.

35. Apparatus according to claim 22 wherein the computer processor is further programmed for modifying weights to control intensity contrast between aggregates during recursive coarsening.

36. Apparatus according to claim 22 wherein the computer processor is further programmed for determining variance of an aggregate relative to a neighboring aggregate.

37. Apparatus according to claim 22 wherein the computer processor is further programmed for determining multiscale variance of an aggregate to detect its texture.

38. Apparatus according to claim 22 wherein the computer processor is further programmed for determining average variance at finer scales to determine a relationship between aggregates.

39. A method for finding correspondence between portions of two images comprising the steps of

a) subjecting the two images to segmentation by weighted aggregation,
b) constructing directed acylic graphs from the output of the segmentation by

weighted aggregation to obtain hierarchical graphs of aggregates, and

c) applying a maximally weighted subgraph isomorphism to the hierarchical graphs of aggregates to find matches between them. Two algorithms are described, One seeks a one-to-one matching between regions. The other computes a soft matching that is an aggregate may have more than one corresponding aggregate.

d) Recovering epipolar lines and camera motion using such correspondences.

40. Apparatus for finding correspondence between portions of two images comprising:

means for subjecting the two images to segmentation by weighted aggregation to obtain full multiscale pyramidal representations of the images,

means for constructing directed acylic graphs from the full multiscale pyramidal representations of the images to obtain hierarchical graphs of aggregates,

means for applying a maximally weighted subgraph isomorphism to the hierarchical graphs of aggregates to find matches between them using an algorithm that matches between regions, and

means for recovering epipolar lines and camera motion using such correspondences.

41. Apparatus according to claim 40, wherein the algorithm computes a soft matching such that an aggregate may have more than one corresponding aggregate.

42. Apparatus according to claim 40, wherein the algorithm computes a one-to-one matching between regions

43. A method for finding correspondence between portions of two images comprising the steps of:

e) subjecting the two images to segmentation by weighted aggregation employing a series of coarsening in successively coarser levels,

f) modifying the weights in each successive level to incorporate coarser measures of difference between neighboring aggregates based on a measure of difference between their average intensities and by a measure reflecting their motion profiles, and

g) recovering at the highest level a representation of the correspondence between the portion of the two images.

44. A method according to claim 43 wherein the weight is determined according to

$$w_{ij}^{I}=e^{-\tilde{\beta}|I_i-I_j|},$$

where $I_i$ and $I_j$ denote the intensities of the two neighboring pixels, and $\tilde{\beta}$ is a positive constant, and a measure $w_{ij}^{M}$ reflecting the difference in the motion profiles associated to the two pixels.

45. Apparatus for finding correspondence between portions of two images comprising:

a. means for subjecting the two images to segmentation by weighted aggregation employing a series of coarsening in successively coarser levels,

b. means for modifying the weights in each successive level to incorporate coarser measures of difference between neighboring aggregates based on a measure of difference between their average intensities and by a measure reflecting their motion profiles, and

c. means for recovering at the highest level a representation of the correspondence between the portion of the two images.

46. Apparatus according to claim 45 further including:

means for determining the weight according to

$$w_{ij}^{I}=e^{-\tilde{\beta}|I_i-I_j|},$$

where $I_i$ and $I_j$ denote the intensities of the two neighboring pixels, and $\tilde{\beta}$ is a positive constant, and a measure $w_{ij}^{M}$ reflecting the difference in the motion profiles associated to the two pixels.

47. A method for finding correspondence between portions of two images comprising the steps of:

a) *select two images* $Im_1$ *and* $Im_2$,

b) prepare for each pixel in $Im_1$ a motion profile,

c) assign a weight to each pair of neighboring pixels according to a

normalized correlation between their motion profiles,

d) perform a coarsening iteration by

e) clustering and re-estimation wherein clustering is achieved by selecting a set of seeds such that the remaining elements are strongly connected to this set, and defining the strength of association of a fine element *i* to a coarse seed *k*, *and* wherein re-estimation is achieved for each seed by determining the motion profile of the seed by multiplying the motion profiles of its children, determining whether the seed is peaked or bar-peaked, accumulating adaptively, moments (orders one to four) originated by peaked seeds, and accumulating separately, moments (orders one and two) by bar-peaked seeds, and

f) determining motion by selecting a model according to constraints from one of translation, affine transformation and fundamental matrix, determining for each neighboring seeds a distance, and modifying the similarities between neighboring seeds according to the determined distance.

48. A method for finding correspondence between portions of two images comprising the steps of:

a) select two images $Im_1$ and $Im_2$,

b) prepare for each pixel in $Im_1$ a motion profile,

c) assign a weight to each pair of neighboring pixels according to a normalized correlation between their motion profiles,

d) perform a coarsening iteration to aggregate segments by

i. clustering and re-estimation wherein clustering is achieved by selecting a set of seeds such that the remaining elements are strongly connected to this set, and defining the strength of association of a fine element to a coarse seed, and wherein re-estimation is achieved for each seed by determining the motion profile of the seed by multiplying the motion profiles of its children,

e) continuing the coarsening iteration until a cluster is detected.

49. A method according to claim 48, wherein the coarsening iteration determines segments adaptively.

50.A method according to claim 48, wherein the coarsening iteration uses bottom-up processing to disambiguate motion profiles.

51. A method according to claim 49, wherein the motion of segments is varied according to a motion model with the level of scale determined by the amount of statistics that appears in each segment.

52. A method according to claim 51, wherein the motion model varies from translation at fine levels, through affine and projective transformations in intermediate levels to 3D rigid motion followed by perspective projection (characterized by a fundamental matrix).

53. A method according to claim 48, wherein the coarsening iteration produces a pyramid and motion is determined by combining constraints collected adaptively from different levels of scales in the pyramid.

54. A method according to claim 48, wherein motion between the images is used to reconstruct a 3D structure of the scene depicted by the images.

55. Apparatus for finding correspondence between portions of two images comprising a computer processor programmed:

a. for selecting two images $Im_1$ and $Im_2$,
b. for preparing for each pixel in $Im_1$ a motion profile,
c. for assigning a weight to each pair of neighboring pixels according to a normalized correlation between their motion profiles,
d. for performing a coarsening iteration by
e. for clustering and re-estimation wherein clustering is achieved by selecting a set of seeds such that the remaining elements are strongly connected to this set, and defining the strength of association of a fine element *i* to a coarse seed *k*, *and* wherein re-estimation is achieved for each seed by determining the motion profile of the seed by multiplying the motion profiles of its children, determining whether the seed is peaked or bar-peaked,

accumulating adaptively, moments (orders one to four) originated by peaked seeds, and accumulating separately, moments (orders one and two) by bar-peaked seeds, and

f. for determining motion by selecting a model according to constraints from one of translation, affine transformation and fundamental matrix, determining for each neighboring seeds a distance, and modifying the similarities between neighboring seeds according to the determined distance.

56. Apparatus for finding correspondence between portions of two images comprising a computer processor programmed:

a. for selecting two images $Im_1$ and $Im_2$,

b. for preparing for each pixel in $Im_1$ a motion profile,

c. for assigning a weight to each pair of neighboring pixels according to a normalized correlation between their motion profiles,

d. for performing a coarsening iteration to aggregate segments by

ii. clustering and re-estimation wherein clustering is achieved by selecting a set of seeds such that the remaining elements are strongly connected to this set, and defining the strength of association of a fine element to a coarse seed, and wherein re-estimation is achieved for each seed by determining the motion profile of the seed by multiplying the motion profiles of its children,

e. for continuing the coarsening iteration until a cluster is detected.

57. Apparatus according to claim 48, wherein the coarsening iteration determines segments adaptively.

58. Apparatus according to claim 48, wherein the coarsening iteration uses bottom-up processing to disambiguate motion profiles.

59. Apparatus according to claim 49, wherein the motion of segments is varied according to a motion model with the level of scale determined by

the amount of statistics that appears in each segment.

60. Apparatus according to claim 51, wherein the motion model varies from translation at fine levels, through affine and projective transformations in intermediate levels to 3D rigid motion followed by perspective projection (characterized by a fundamental matrix).

61. Apparatus according to claim 48, wherein the coarsening iteration produces a pyramid and motion is determined by combining constraints collected adaptively from different levels of scales in the pyramid.

62. Apparatus according to claim 48, wherein motion between the images is used to reconstruct a 3D structure of the scene depicted by the images.